













TTCB FM Vibration test procedure **Thermal Control AMS Tracker** Subsystem

Issue

May 14 2009

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Nationaal Lucht- en Ruimtevaartlaboratorium

National Aerospace Laboratory NLR

















AMS Tracker Thermal Control Subsystem TTCB FM Vibration test procedure

I may box

ISSUE 3.0 AMSTR-NLR-PR-030 MAY 14 2009

Instituto Nazionale di Fisica Nucelare (INFN) National Aerospace Laboratory (NLR) Sun Yat-Sen University (SYSU)

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Document change log

Change Ref.								Change Ref.	ı	Change Ref.
Section(s) 4.1	7.3	7.2	7.1	5.0		5.0	4.1	Section(s)	All	Section(s)
lssue 3.0 Modified location on pump and changed to a 3-axis type	Related steps to ENEA facility deleted	Related steps to ENEA facility deleted	Related steps to ENEA facility deleted	Modified test sequence for TTCBP & TTCBS	not in Rome	Step 3-4-5 and 10-11-12 deleted: test is performed in Teri and	Modified location and name of the accelerometer	Issue 2.0	Initial issue	Issue 1.0

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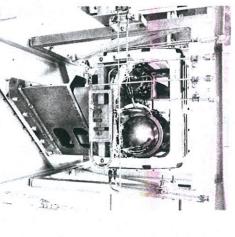


Figure 2-2: Picture of TTCB-Primary FM

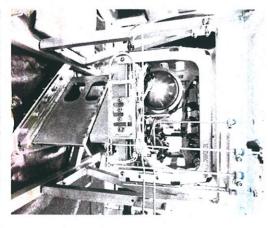


Figure 2-3: Picture of TTCB-Secondary FM

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1 Scope of the document and test objective



Level Vibrations. Before and after the test functional checks are performed to compare the The objective of the test is to demonstrate the TTCB's can withstand Minimum Workmanship system health prior and after tests. This document contains the vibration test procedure for the TTCB-P FM and the TTCB-S FM.

2 Hardware under test

HX, 2 x APS, 2 x DPS, several heaters, Pt1000's and Dallas DS18s20 temperature sensors, and components: I pump electronics box connected by an electrical cable to 2 pumps, accumulator, are flight hardware. A TTCB consists of completely integrated unit with the following The hardware subjected to the vibration test are the TTCB-P FM, TTCB-S FM. Both models integrated TTCB start-up radiators.

The items are shown in Figure 2-1 to Figure 2-3.

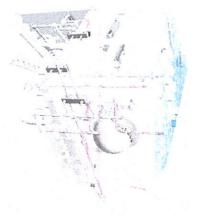


Figure 2-1: TTCB-Primary Box (3D-Model)

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4.1 Location of accelerometers

The accelerometer to control the table will always be located on the interface plate with the vibration table. The position will be changed according to the test axis to be performed.

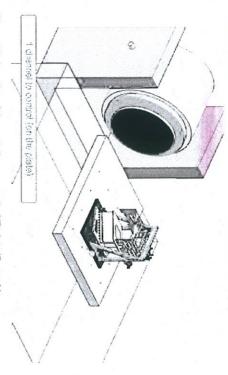


Figure 4-2: Location of the control sensor on the I/F plate (first axis)

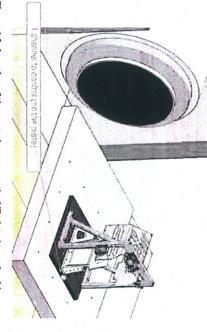


Figure 4-3: Location of the control sensor on the I/F plate (second axis)

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3 Test Requirements and success criteria

acceleration

The test is successful when the following requirements are fulfilled.

- No visual damage of the test article is found.
- No significant discrepancies between pre- and post sine sweep curve response
- All mechanics frequencies are above 50Hz
- Functional check before and after show no discrepancies % \gtrsim

4 Test facility description and measurement equipment

The test is performed at in Terni.

The following equipment will be used:

- Vibration test facility
- Digital camera for documentation of visual inspection
- Accelerometers to monitor and control the vibration
- Additional 3-axis accelerometer to monitor the pump vibrations

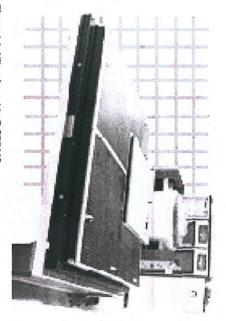


Figure 4-1: Vibration table @ SERMS

















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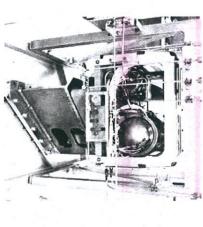


Figure 4-6: Locations of the response accelerometer 2 on the TTCB



Special accelerometer close to the pumps

An additional 3-axis sensor will be located on or close to the pumps so the vibration levels of the most critical component are monitored. This should be done to be sure the pumps are not



Figure 4-7: Location of the accelerometer close to the pumps (also used for 3rd axis

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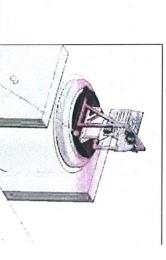


Figure 4-4: Location of the control sensor on the I/F plate (third axis)

base plate is the most representative part the locations proposed are as close to the base plate as possible. Two other sensors will be applied to measure the response in the orthogonal directions. As the

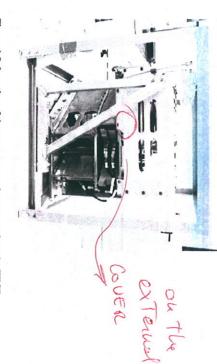


Figure 4-5: Location of the response accelerometers 1 on the TTCB









6 References documents

RD-1

TTCS Requirements

AMSTR-NLR-PL-02 Issue 1.0

April 2007

Verification Matrix FM H/W

Title

The steps for the SECONDARY box are exactly the same as for PRIMARY



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5 Test Procedure in main steps

The main test procedure steps for the PRIMARY box are:

- Perform functional check TTCB at SERMS in Termi according to AMSTR-NLR-PR-028 "TTCB Limited functional check Vibration procedure"
- Close valves and decouple test loop from the TTCB
- Monitor the environment temperature during vibration testing
- Perform first axis vibration test on TTCBP
- Install the TTCB on the vibration facility
- Perform a pre sine sweep to detect large workmanship failures and to characterize the system mechanics before vibration
- Stop test as soon as failures are detected
- Perform first axis random vibration test
- Perform post sine sweep to characterize the system mechanics after vibration
- e. Perform visual inspection
- Perform second axis vibration test on TTCBP
- Install TTCB in second vibration axis
- Perform pre sine sweep to characterize the system mechanics after vibration
- Perform second axis random vibration test
- d. Perform post sine sweep to characterize the system mechanics after vibration
- e. Perform Visual inspection
- Perform frist axis vibration for TTCB S
- Perform second axis vibration fro TTCB S
- Perform third axis vibration test for TTCB P
- a. Install TTCB in third vibration axis
- b. Perform pre sine sweep to characterize the system mechanics after vibration
- Perform third axis random vibration test
- Perform post sine sweep to characterize the system mechanics after vibration
- e. Perform visual inspection
- Perform third axis vibration test fro TTCB S
- 10. Couple loop to TTCB and open valves
- 11. Perform functional check according to AMSTR-NLR-PR-028

Yellow are preparation pre-test sheets; Red are vibration test sheets

Green are post-test sheets

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7.1 TTCB vibration pre-test procedure sheets

	TTCB Box pre-test vibration sheets		company:		date:		
	Fill in by hand.		engineer:		location:		
Step	Action	Monitoring	Value	Result	Comment	1	
1.	Record model type		P/S	P			
2.	Perform filling of the vibration test loop according to AMSTR- SYSU-PR-024 FM TTCB Filling and venting procedure			OK		V	
3.	Copy the measured volume of the TTCB (total volume-volume external loop parts)		(Litre)	1.2418			
4.	Copy the filling rate here		(g/litre)	557 2			
5.	Define maximum allowed temperature during vibration test	+62,	(°C)	som ghe	Copy to Appendix B table	100	
6.	Perform functional test according to AMSTR-NLR-PR-028	4	mar Tfor		See separate procedure		
7.	4 4		160 bes	with 55	79/l from nell	rer	diagram
*	TTCB 4 1/4"			ok			
	Close the valves connecting the loop						
8.	Monitor Test Environmental Temperature during testing	- W	(°C)		Automatic or table app B.	0	

ME)







7 TTCB Vibration overall test procedure

The TTCB vibration test procedure sheets consist of 3 parts.

3. TTCB vibration post-test vibration sheets 2. TTCB vibration vibration sheets 1. TTCB vibration pre-test vibration sheets

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Date	May 14 2009

	TTCB Box pre-test vibration sheets		company:		date: 9/5/2005 location:		
1.00	Fill in by hand.		engineer: 2	2/AP			
Step	Action	Monitoring	Value	Result	Comment	V	
17.	Look inside box for						
	-Loose particles due to shaving					1,	
	- Loose cables/harnesses			./_		10	
	- Loose bolts/nuts						
	- Loose shaving protection of rivnuts						
18.	Attachment of glued components	PT1000		04			
		heaters		OL		0	
		DS18s20		010			
19.	Cable harness	Chafing/mounting		ok		12	
20.	Take pictures of TTCB from all sides						
21.	End of sheet						





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٠.	TTCB Box pre-test vibration sheets	SEE SEE	company:	(marketti)	date: 19/5/20	#0G
1944	Fill in by hand.		engineer:		location:	
Step	Action	Monitoring	Value	Result	Comment	1
9.	Install accelerometers					
10.	Install the accelerometer to the Vibration I/F plate (figure 4.2)	Type/location	***************************************	640		U
11.	Install the accelerometer 1 to the TTCB sides (see section 4.1)	Type/location		ou		V
12.	Install the accelerometer 2 to the TTCB sides (see section 4.1)	Type/location		6/2		
13.	Install accelerometer close to the pumps (see section 4.1)	Type/location		OR		~
14.	Install the TTCB on the vibration table in first direction Fasten flight bolts according to ATS of TTCB and fill forms Fasten non-flight bolts fill forms			oh		
15.	Perform visual inspection prior to test					
16.	Visual inspection, unaided eye, look at outer surface for - scratches	scratches				
	- dents	Dents			, ,	
	- cleanliness	Particles/grease	50000		not in cleannou	-





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	TTCB Vibration test sheets	WARRY THE	company:		date: 15/5/2004	1.11
-43,73	Fill in by hand.		engineer:		location:	
Step	Action	Monitoring	Value	Result	Comment	1
10.	Check that the frequencies of the mechanics are well above 50Hz Document "response" curves			OK	4	4
11.	Document the last characterisation "response curve"		file name		report Antive	
12.	Perform visual inspection after test					
13.	Visual inspection, unaided eye, look at outer surface for - scratches - dents - cleanliness Look inside box for -Loose particles due to shaving - Loose cables/harnesses - Loose bolts/nuts - Loose shaving protection of rivnuts	scratches Dents Particles/grease		Some par	ticles no deanna	004
15.	Attachment of glued components	PT1000 heaters DS18s20		1		
16.	Cable harness	Chafing/mounting				
17.	Take pictures of TTCB from all sides					





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7.2 TTCB vibration test sheets

:	TTCB Vibration test sheets		company:		date:	4. * '
435	Fill in by hand.		engineer:		location:	
Step	Action	Monitoring	Value	Result	Comment	V
1.	Record model type		P/S	1		
2.	Scanning test to check loose parts and characterise					
3.	Perform one PRE sine sweep from 5 to 1000 Hz 0,2 G - scan rate 1 oct/min	Check loose parts			If any loose parts are detected stop test	$ $ \vee
4.	If loose parts are detected improve attachments					
5.	Check that the frequencies of the mechanics are well above 50Hz Document "response" curves					L
6.	Repeat step 2-5 until no loose parts detected					,
7.	Document the last characterisation "response curve"		Write down		Report Antonio	
8.	Perform Random Vibration test first axis according to spectrum in Appendix A.					/
9.	Perform one POST sine sweep from 5 to 1000 Hz 0,2 G – scan rate 1 oct/min					









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14 THE	TTCB Vibration test sheets		company:	(de Problem 1977)	date:	A. F
i jagi	Fill in by hand,		engineer:		location:	
Step	Action	Monitoring	Value	Result	Comment	1
25.	Look inside box for					
	-Loose particles due to shaving			de la companya della companya della companya de la companya della		
	- Loose cables/harnesses			general control		1
	- Loose bolts/nuts			parent .		
	- Loose shaving protection of rivnuts			<u>.</u>		
26.	Attachment of glued components	PT1000				
		heaters				10
		DS18s20				ᆜ_
27.	Cable harness	Chafing/mounting		1		
28.	Take pictures of TTCB from all sides			X		X
29.	Perform one PRE sine sweep from 5 to 1000 Hz	Check loose		` <u>`</u>	If any loose parts are	T
	0.2 G – scan rate 1 oct/min	parts			detected stop test	
30.	Check that the frequencies of the mechanics are well above 50Hz Document "response" curves					
31.	Document the last characterisation "response curve"		file name			
32.	Perform Random Vibration test second axis according to spectrum in Appendix A.					









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	TTCB Vibration test sheets		company:		date:	
	Fill in by hand.		engineer:		location:	14
Step	Action	Monitoring	Value	Result	Comment	V
18,	End of first axis vibration					
19.	Second axis Vibration test					
20.	Rotate 90° the plate (without unscrewing the bolt between box and fixture) to perform the second axis					<u> </u>
21.	Install accelerometers				by Antonio	
22.	Install the accelerometer to the Vibration I/F plate (figure 4.3)	Type/iocation			Indicate location/orientation change	
23.	Perform visual inspection prior to test					
24.	Visual inspection, unaided eye, look at outer surface for					
	- scratches	scratches				14
	- dents	Dents				
	- cleanliness	Particles/grease		hartice	10	





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	TTCB Vibration test sheets		company:		date:	
	Fill in by hand.		engineer:		location:	
Step	Action	Monitoring	Value	Result	Comment	1
		heaters DS18s20				
40.	Cable harness	Chaffing/mounting	5			
41.	Take pictures of TTCB from all sides	ē .			a	
42.	End of second axis vibration					T
43.	Third Axis Vibration test - 200 9-05 - 20.					
44.	Install the TTCB on the vibration table in third axis direction Rotate 90° the plate (without unscrewing the bolt between box and					V
	fixture) to perform the second axis Fasten non-flight bolts	1/2 -x = 8				





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	TTCB Vibration test sheets		company:		date:	
	Fill in by hand.		engineer:		location:	
Step	Action	Monitoring	Value	Result	Comment	1
33.	Perform one POST sine sweep from 5 to 1000 Hz 0,2 G – scan rate 1 oct/min				2 X	
34.	Check that the frequencies of the mechanics are well above 50Hz Document "response" curves					/
35.	Document the last characterisation "response curve"	8 8 8	file name	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	ly Antonio.	
36.	Perform visual inspection after test					
37.	Visual inspection, unaided eye, look at outer surface for - scratches - dents - cleanliness	scratches Dents Particles/grease				
38.	Look inside box for -Loose particles due to shaving - Loose cables/harnesses - Loose bolts/nuts - Loose shaving protection of rivnuts					
39.	Attachment of glued components	PT1000			7 85 (%)	







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	Fill in by hand.		engineer:		location:	
Step	Action	Monitoring	Value	Result	Comment	1
52.	Take pictures of TTCB from all sides					V
53.	Perform one PRE sine sweep from 5 to 1000 Hz 0,2 G scan rate 1 oct/min	Check loose			If any loose parts are detected stop test	V
54.	Check that the frequencies of the mechanics are well above 50Hz Document "response" curves	1				
55.	Document the last characterisation "response curve"	4000	file name		by Antonio	
56.	Perform Random Vibration test third axis according to spectrum in Appendix A.	2 15 X	194	7.2.		V
57.	Perform one POST sine sweep from 5 to 1000 Hz 0,2 G - scan rate 1 oct/min	1 12 12 12 12 12 12 12 12 12 12 12 12 12			5 - 7	V
58.	Check that the frequencies of the mechanics are well above 50Hz Document "response" curves					V
59.	Document the last characterisation "response curve"		file name		by Antonio.	١
60.	Perform visual inspection after test					
61.	Visual inspection, unaided eye, look at outer surface for - scratches	scratches		4		







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	TTCB Vibration test sheets		company:		date: 2009-05 -	20'
	Fill in by hand.		engineer:		location:	
Step	Action	Monitoring	Value	Result	Comment	1
45.	Install accelerometers (if needed)			12.0		
46.	Install the accelerometer to the Vibration I/F plate (figure 4.4)	Type/location			Indicate location/orientation change	
47.	Perform visual inspection prior to test					
48.	Visual inspection, unaided eye, look at outer surface for - scratches - dents - cleanliness	scratches Dents Particles/grease				V
49.	Look inside box for -Loose particles due to shaving - Loose cables/harnesses - Loose bolts/nuts - Loose shaving protection of rivnuts					V
50.	Attachment of glued components	PT1000 heaters DS18s20			200	V
51.	Cable harness	Chafing/mounting				V





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7.3 TTCB vibration post-test procedure sheets

	TTCB Box post-test vibration sheets		company:		date:	
	Fill in by hand.		engineer:		location:	
Step	Action	Monitoring	Value	Result	Comment	1
1.	Record model type		P/S		135 10 20 101	,
2.	Check temperature monitoring during testing has been performed according to appendix B.	3			see apper	dix
3.	Perform functional test according to AMSTR-NLR-PR-028				See separate procedure	
 4. 5. 	Perform venting of the vibration test loop according to AMSTR- SYSU-PR-024 FM TTCB Filling and venting procedure End of sheet					





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	TTCB Vibration test sheets		company:		date:		
	Fill in by hand.		engineer:	7.	location:		
Step	Action	Monitoring	Value	Result	Comment		1
	- dents - cleanliness	Dents Particles/grease		particle	no	clearro	DA
62.	Look inside box for -Loose particles due to shaving - Loose cables/harnesses - Loose bolts/nuts - Loose shaving protection of rivnuts		2 2	111	2 9,		ı
63.	Attachment of glued components	PT1000 heaters DS18s20		11.1			L
64.	Cable harness	Chafing/mounting		/			L
65.	Take pictures of TTCB from all sides	3 T					2
66.	End of third axis vibration	1			, 2		

X 2 wires RMP-rad heaters cut during mounting Z-axis vibration

X accelerometers have glased on Alu-tape. Ala tape

directly on TT(B (No kapton tape used)









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The requirements are as follows.

The TTCB's are subjected to Minimum Workmanship Level Vibration testing.

Table 15-2: Minimum Workmanship Levels for the Alpha Magnetic

Spectrometer - 02

20117

All Axes

500-2000 182

3 dB Octave

0.04 g-11z

0.01 g-117

3 dB Octave

111.7 (0.0)

2000 Hz

Appendix A: Vibration profiles and levels



TTCB FM Vibration test procedure

Subsystem

Issue Date

May 14 2009

3.0

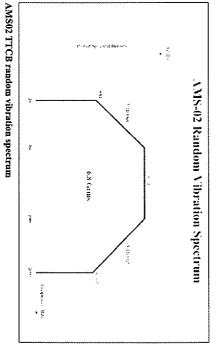
AMSTR-NLR-PR-030

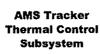


Note: MWE Test distribute on seconds per axis

Overall - 6.8 Grms

The profile is shown in the below figure.





TTCB FM Vibration test procedure

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Fill every 15 minutes

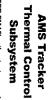
Max allowed temperature

(Will be used as reference to show to NASA P_{TTCB}< MDP (160 bar)

Appendix B: Temperature fill table during vibration test

Time





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TTCB FM Vibration test procedure











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TTCB FM Vibration test procedure

Sine sweep from 5 to 1000 Hz - 0,2G - scan rate I oct/min

characterize the TTCB response curves. The Sine sweep definition is as follows.

Before and after each axis random vibration test a sine sweep is performed to characterise to

Write down max allowed Temperature (based on filling):..... TTCB Model (Primary/Secondary) Temperature monitoring during Vibration testing (In case the maximum allowed temperature is almost reached fill every 5 minutes) Temperature [C][°C]











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Appendix C: I/F plate mechanical lay-out instructions TTCB FM Vibration test procedure Subsystem

Error! Objects cannot be created from editing field codes.

Error! Objects cannot be created from editing field codes.

Temperature monitoring during Vibration testing Write down max allowed Temperature (based on filling)	bration testing d on filling):
TTCB Model (Primary/Secondary)	
Time	Temperature [C]
The second secon	









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Error! Objects cannot be created from editing field codes.

Error! Objects cannot be created from editing field codes.

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AMSTR-NLR-PR'-030 ISSO Temperature log Primary box

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bee	pron clean	Proom T=22'		
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	10 7+	745		
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-	10:42.	24.0.	23.1	
	10:55	23.8	>3/	
	1100	23.8	22.9	
	11219	23.9	23.2.	
	1121	24,8	54,3	vibrohis
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- The state of the				

AMSTR-MR-PR-030 Primary box during vibration

ISS 30. Max Tallowed = 62°C (> MOP=160 box

Temperature Tmax, during test = 27.4°C (>) isof 5 / hong

log. TTCD-p filled with CO: on slipted

cones ant of good clinck chanber Temperature Tacca (°C) Tover time 11 25 1220 17 30 27.0 12 46 12 11 27.2 1218 1331 1436-76.0 1457 1545 Conclusion: Remark: T is logged in climate chamber T < Tmox, obvingtest.